during contraction, and it furnishes results identical to those obtained by investigating the shortening of the muscle during contraction in living animals. We are then quite authorised to interpret in the same way the curves obtained in both cases.

It is needless to insist on the numerous services which the myography of man may render to physiology and medicine. The study of the forms of movement, of the latent period, of muscle, and perhaps even the rate of transmission of impulses along motor nerves, by means of this apparatus may be as easily pursued in healthy or unhealthy men as in animals.

2. Without quitting the investigation of muscular movements, let us examine that of the respiratory movements, and we shall obtain valuable information as to the means by which the important function of respiration is effected. We apply to the chest this apparatus formed of an elastic plate and furnished with two lever arms, to the extremity of which is attached a band which surrounds the thorax. Each dilatation of the chest causes the spring to bend, and it resumes its position during respiration. This double movement is accompanied by a rising and falling of the membrane of the drum which forms part of the apparatus, and which therefore becomes a regular bellows, causing the elevation and depression of the inscribing lever placed beside the cylinder.

The respiratory curves thus obtained present certain normal characteristics susceptible of being greatly modified when any obstruction interferes with the respiratory functions either by impeding the entrance or the exit of the air, or even by opposing its passage in both directions. In all these cases the curves have a special physiognomy, and their simple inspection enables us to recognise the seat of the obstacle to respiration. Clinical research will yet discover here many points for investigation.

3. But above all there are the phenomena of circulation, which have been minutely investigated both in man and animals. The apparatus by means of which we can completely analyse the movement of the heart, the arterial pulse, &c., have already rendered great service; we are, however, right in expecting yet more from it, by making use of it in clinical investigations.

Of various cardiographs, that on which I wish to dwell differs little from the explorer of which I have already spoken. The knob with which it is provided is applied to the region of the apex of the heart, and each beat of the organ is transmitted to the recording lever. There is seen in this pulsation of the heart the same elements which the physiological cardiograph has revealed in the higher animals. This beating of the heart is then a complex act, and the numerous details which have been discovered by graphic analysis have each a considerable importance from the point of view of functional investigation. One part of the tracing shows us how the ventricle is emptied into the artery; another enables us to appreciate the play of the auricle, the beating of the sigmoid valves, &c. You will easily see that the precise diagnosis of affections of the heart, already carried so far, thanks to auscultation, will be greatly improved by the application to man of the cardiograph applied to the study of the pulsation of the heart.

The arterial pulse cannot be separated from the pulsation of the heart in the study of the phenomena of circulation in man. Already numerous researches have been undertaken by means of the direct sphygmograph; but much more may be expected from the use of the air sphygmograph (*sphygmographe à transmission*).

I place this apparatus upon my wrist, and the artery raising a spring connected with the membrane of the exploring drum, transmits its movement to a distance by means of the tube filled with air, which enables this sphygmograph to communicate with the drum to which the recording lever is attached. By recording simultaneously the traces of the pulse and those of the heart much information may be obtained and many errors avoided.

4. I shall present to you, in conclusion, a new method of investigating the peripheral circulation. This method is based on the principle that the variation of the calibre of the blood-vessels in any part of the body is faithfully indicated by the variations of the volume of that part. Without dwelling on the history of these investigations, I may tell you that they originated many years ago, Dr. Piégu, of Paris, having pointed out in 1846 the alternate expansion and contraction of the tissues in connection with the dilatation and contraction of the blood-vessels. Since that time Chelius and Fick in Germany, Mosso in Italy, Franck at Paris, have carried on and extended these researches.

The recording of the movements of a column of water inclosed in a tube communicating with a receiver filled with water and into which the hand and forearm is plunged, was first effected by Fick by means of a float armed with a pen. Ch. Buisson hit on the happy idea of transmitting to a distance, by means of tubes filled with air, the oscillation of the column of water, and it is with his apparatus that M. Franck, in my laboratory, has executed a series of researches. You see the apparatus in action. The hand is plunged into this jar filled with water and hermetically closed. A vertical tube, furnished with a bulb to avoid the effects of the speed acquired by the liquid, serves to transmit to a recording lever the oscillation of the column of water. You will remark that these oscillations are rhythmical with the heart, and if we record them by the side of the cardiac pulse registered by the transmitting sphygmograph, we can establish the identity of the variations in size or, as we may term them, the pulsations of the hand and of the pulsations of a single artery. With this apparatus we may perform numerous experiments on the mechanical effects of compression of the arteries or veins, the action of the vaso-motor system of nerves, direct or reflex, &c.

I shall not explain to you by the side of this method of investigation, that which we owe to Mosso, of Turin. His plethysmograph, which ought soon to be presented to you, permits the estimation of changes of volume of the hand, and, assuredly, the combination of these two processes ought to lead to important results in the investigation of the phenomena of peripheral circulation.

I have sought to submit to you some of the points more immediately applicable to man, without dwelling on the investigation of the movements among animals. But these two orders of researches complement each other. We may say that most of the data furnished by experimentation on animals are now susceptible of rigorous verification on man, healthy or unhealthy. This verification we owe to investigation by means of precise apparatus and to the recording of the smallest movements, thanks to the registering instruments, the principal specimens of which are shown in this Collection.

DREDGINGS OF THE "CHALLENGER"

PROF. WYVILLE THOMSON had not set foot long in Old England before presenting in person a preliminary quota of his results to the learned bodies. Two papers read by him at the Linnean Society on June 1, embodied observations on Echinodermata, a group to which, as is well known, he previously had paid much attention. One of the communications described some new living Crinoids belonging to the Apiocrinidæ. Of deep-sea forms the stalked crinoids are extremely rare, and have a special interest on account of their palæontological relations; it was therefore with satisfaction that near St. Paul's rocks at 1,850 fathoms, the trawl brought up, among other things, an entire specimen of a new crinoid, *Bathycrinus Aldrichianus*, and fragments of another, *Hyocrinus bethellianus*. At other stations and on different occasions, were obtained another species of *Bathycrinus* (*B. gracilis*) and an undetermined beautiful little species of *Hyocrinus*, besides examples of the *Rhizocrinus lofotensis* of Sars; all of these being referable to the Apiocrinidæ. In pointing out their structural peculiarities and alluding to *Bathycrinus*, he mentioned that the stem barely enlarges at its junction with the cup, the ring formed by the basals is very small, and the first radials are free from the basals and often free from one another, while the oral plates are absent. This genus appears to possess an assemblage of characters in some respects intermediate between *Rhizocrinus* and the pentacrinoid stage of *Antedon*. *Hyocrinus bethellianus* has much the appearance, and in some prominent particulars it seems to have very much the structure of the palæozoic genus *Platycrinus* or its sub-genus *Dichocrinus*. The stem is much more rigid than that of *Bathycrinus*; the cup consists of two tiers of plates only, the lower is to be regarded as a ring of basals, and the upper consists of fine spade-shaped radials. There are five arms which are pinnulated. The proximal pinnules are very long, running on nearly to the end of the arm, and the succeeding pinnules are gradually shorter, all of them, however, running out to the end of the arm. Distally the ends of the five arms, and the ends of all the pinnules meet nearly on a level. This arrangement is unknown in recent crinoids, although we have something close to it in species of the fossil genera *Poteriocrinus* and *Cyathocrinus*; with this, however, their resemblances end. *Rhizocrinus* finds its ally in the cretaceous genus *Bourgueticrinus*; *Bathycrinus* and *Hyocrinus* are evidently related to the former, but the characters of the Apiocrinidæ are nevertheless obscure in

the two latter. In his second paper Prof. Wyville Thomson drew attention to peculiarities in the mode of propagation of certain Echinoderms of the Southern Sea. He passed in review examples of the Sea-cucumbers (*Holothuroids*), Sea Urchins (the circular *Cidaroids*, and heart-shaped, *Spatangoids*), Star-fish (*Asteroids*), and the Brittle Stars (*Ophiuroids*). In allusion to their phases of development he stated the majority of these pass from the egg without the intervention of a locomotive pseudembryo. Among other data in support of this view he said, that while in warm and temperate seas "plutei" and "bipinnari" were constantly taken in the surface-net; yet during the southern cruise between the Cape of Good Hope and Australia, only one form of Echinoderm pseudembryo occurred, and which was considered with some little doubt as the larva of *Chirodota* from the presence of dermal, calcareous, wheel-shaped spicules. Furthermore Prof. Wyville Thomson described in detail the almost constant occurrence among the majority of the foregoing groups a curious, receptacular pouch wherein the young are carried until arriving at a certain maturity. This marsupium is situated on the dorsal portion of the body, is composed of a series of plates which meet centrally and permit of the young creeping about and returning to it for shelter. The young derive no nutriment from the parent while contained in the "nursery," other than it may be a mucous secretion.

THE U.S. WEATHER MAPS[1]

IN this fourth contribution to meteorology, Prof. Loomis discusses certain points of a miscellaneous nature which have been either very slightly or not at all examined in his three previous contributions. The movements of areas of high barometer, which are of so great importance in their relations to weather and climate, have been examined with the result that while the average track of areas of low pressure across the United States is nine degrees to the north of east, the track of areas of high barometer advance toward a point several degrees south of east, and with a velocity somewhat less than the former.

As regards the conditions under which the monthly minima of temperature occur, it is shown that these conditions, viz., winds very light, sky clear, and pressure above its mean height, are substantially the same at Jakutsk, Siberia, as at New Haven. Prof. Loomis is of opinion that it is true universally that periods of unusual cold are generally accompanied by a barometer above the mean, and by a descent of air from the upper regions of the atmosphere. These areas of high barometer have a broader significance than is here implied. It is the still, clear, and dry atmosphere accompanying them, *and its relations to terrestrial and solar radiation*, which afford the conditions of extreme temperatures. The monthly minima of the cold months of the year and the maxima of the warm months both frequently occur under the conditions afforded by areas of high pressure. On the other hand, in North-western Europe it is often observed that the minima of temperature during the warm months repeatedly occur within areas of low pressure where very light easterly and northerly winds prevail. In discussions of the relations of temperature and pressure, it is seldom kept steadily in mind that the given temperature is merely the temperature observed within a few feet of the earth's surface, which, as regards areas of high pressure, will nearly always mislead if it be used as a basis from which to estimate the temperature of the higher strata vertical to it; the surface temperature being abnormally low in winter from contact with the cooled surface, and in summer abnormally high from contact with the heated surface of the earth.

The examination of storm paths in America, the Atlantic, and Europe is important from the bearing of the subjects on climatology and weather-forecasting. Some interesting results of such an examination are given by Prof. Loomis in the average paths marked on the chart accompanying the paper. The results, however, are not calculated to be practically useful until the average paths be laid down for each month in the year, owing to the very great differences in these paths as regards different months. Thus, in North-western Europe, during the spring months, when east winds are most prevalent in Great Britain, many storm tracks, or the course of barometric depressions, are more southerly, and during the winter months more northerly than that indicated on the chart. If the track of storm-centres in winter generally took the line of The Channel, our winters would, on the average, be much more severe than they are, owing to the greater frequency of easterly and northerly winds, which would necessarily follow. But open winters are the rule in these islands, and even as far north as Faroe, where, during winter, southerly and westerly winds largely preponderate, thus showing that the central tracks of the majority of our winter storms lie to the north of Faroe. The exact determination of the average monthly tracks and the more marked deviations from them would throw light on several important questions affecting the climatology of the whole of North-western Europe.

Since the average velocity of storms over the United States as deduced by Prof. Loomis from 485 cases, is twenty-six miles per hour, and over the Atlantic, as deduced from 134 cases, is 19·3 miles per hour, and the average velocity of European storms as deduced by Prof. Mohn is 26·7 miles per hour, it follows that storms travel less rapidly over the ocean than over continents. If further inquiry confirms this result, we have here a valuable contribution to the theory of storms which will likely lead to a clearer insight into the causes which regulate their rate of propagation over the earth's surface, accelerating it in some cases, and in others retarding it as is frequently seen off the coast of Newfoundland and in the Bay of Biscay.

[1] Results derived from an examination of the United States Weather Maps and other sources. By Prof. Elias Loomis, Yale College. Fourth Paper. From the *American Journal of Science and Arts*, vol. xi., Jan. 1876.

NATURAL SCIENCE AT CAMBRIDGE

THE Cambridge Natural Science Tripos has just entered upon a new phase of existence. The recent examination is the first in which a division into two parts, elementary and advanced, is carried out, the former being held in June and the latter in December. Candidates who do not satisfy the examiners in the first part are not permitted to compete in the second. The final class-list is to be based on the alphabetical principle, but the first class will consist of two divisions, each arranged alphabetically, and the subject or subjects for which a man is placed in the first class are to be indicated, while a special mark will reward superior proficiency. This system removes some of the worst faults of the competitive system, and is of especial benefit to the more able men. One subject will not be pitted against another as regards marks, an accumulation of cramming in several subjects will not serve an inferior man, and clear testimony will be given that a man has a competent knowledge of a subject, or that he is specially proficient in it. With such arrangements, the value of the examination will largely depend upon the wisdom of individual examiners. It will be obvious that there should be at least two examiners in each subject instead of one. Also the pittance they receive should be transformed into fair remuneration, which will, no doubt, be done as soon as the University has more funds at its disposal.

It was to be expected that a new system, by which no man receives any credit in a subject unless he shows satisfactory knowledge of it, and by which the examination is limited to three days, would produce a large number of failures to attain honours. The number of candidates in June was forty-four, a large increase; of these only thirty-one obtained honours, while ten others received the ordinary degree. On scrutinizing the papers, it appears that there is a difficulty in equally adjusting the questions which probably have affected the result. Two questions in each subject, except human anatomy, are given in every paper; one question only is set in human anatomy, which is introduced for the first time. I will quote some of the questions in geology and in physiology, giving fair samples; and it will be plain that they are not equivalent in difficulty, and that students of moderate ability and reading might gain honours by answering the former much more easily than the latter.

"In which of the three great divisions of stratified rocks do fossils of the genera Ichthyosaurus, Phacops, Calamites, Voluta, Terebratula, Ostrea, and Micraster respectively occur?" "Volcanic rocks have been divided into two classes, acidic and basic. Give the name and mineralogical composition of a common rock of each